CLASS – NINE CHEMISTRY **STUDY OF GAS LAWS** Assignment – 1

INTRODUCTION

The state of matter in which inter – particle attraction is weak and inter – particle space is so large that the particles become free to move randomly in the entire available space is known as GAS .

BEHAVIOUR AND CHARACTERISTIC PROPERTIES OF GASES

The kinetic molecular theory , explains the behavior and characteristic properties of gases :

1) **Composition of gases :** Gases are made up of tiny particles moving in all possible directions at all possible speeds .
2) **Gases have neither a fixed volume nor a fixed shape :** There is a negligible force of attraction between the particles and they are free to move in the entire space and their movement is restricted by the walls of the container . This is why , they attain the shape of the container .
3) **Gases exert pressure in all directions :** The moving particles of gas collide with each other and also the walls of the container and exert pressure . This is why , gases exert pressure in all directions .
4) **Gases are highly compressible :** There are large inter – particle spaces and this accounts for the high compressibility of gases . On applying pressure , the molecules come closer , decreasing the volume .
5) **Gases are highly expansible :** Gases increase in volume on decrease in pressure and increase in temperature . When pressure on an enclosed gas is reduced , its particles move apart , thus increasing their inter – molecular spaces . Thus , the volume of the gas increases .
   When an enclosed gas is heated , kinetic energy of its molecules increases . Therefore , the molecules start moving faster and farther apart from each other , resulting in an increase in the volume of the gas .
6) **Gases have low density :** The number of molecules per unit volume in a gas is very small as compared to solids and liquids . Gases have large inter – molecular space between their molecules . Thus , gases have very low density .
7) **Gases have a tendency to diffuse :** The inter – molecular spaces in a gas is very large and when two gases are brought in contact with each other , their molecules mix with each other to form a homogeneous gaseous mixture .
8) **Gases can be liquefied :** On cooling , the kinetic energy of the molecules of a gas is reduced and on applying pressure on a cooled gas , the molecules comes closer . Hence , the inter – molecular space gets reduced and there is an increase in the number of molecules per unit volume . Thus , the gas liquefies .

MOLECULAR MOTION : RELATIONSHIP OF TEMPERATURE , PRESSURE AND VOLUME .

The average kinetic energy of a particle is directly proportional to its absolute temperature .
As temperature increases , molecular motion increases , and when temperature decreases , molecular motion decreases . When the temperature is zero , molecular motion ceases .

Kelvin scale is also called the absolute scale of temperature .

THE TEMPERATURE AT WHICH THE MOLECULAR MOTION COMPLETELY CEASES , ON THE KELVIN SCALE , IS CALLED ABSOLUTE ZERO .

Absolute Zero or zero Kelvin is equal to – 273 ^{O}C . Temperature lower than absolute zero (- 273 ^{O}C) are not possible .

When a gas is enclosed in a vessel , it exerts uniform pressure on the walls of the container .
The reason is that the particles of the gas collide with each other and with the walls of the container .
Since a large number of particles suffer collision with the wall , force acts on the wall .

Therefore , the force exerted on a unit area of the wall of the vessel is equal to the pressure of the gas

When the temperature of the gas is increased , keeping its volume constant , the average kinetic energy of the gas molecules increases and so the average speed of the molecule also increases . The molecule strikes the wall of the container with great momentum (product of mass and velocity) and the rate of collision of the paticles also increases . So , the force exerted on the walls of the container increases , which results in an increase in the pressure exerted by the gas .

THE GAS LAWS

PRESSURE AND VOLUME RELATIONSHIP IN GASES

* An increase in pressure at constant temperature causes a decrease in the volume of a gas ; and conversely , if the volume of a fixed mass of a gas at a constant temperature is decreased , the pressure of the gas increases .
* A decrease in pressure at constant temperature causes an increase in the volume of a gas . Conversely , if the volume of a fixed mass of a gas at constant temperature is increased , the pressure of the gas decreases .

BOYLE'S LAW : Volume of a given mass of dry gas is inversely proportional to its pressure at constant temperature .

$$P_1V_I = P_2V_2$$

EXPLANATION :- If the volume of a given mass of a dry gas is reduced to half its original volume , the same number of particles will have half the space to move . As a result , the number of molecules striking at unit area of the walls of the container at a given time will get doubled and so the pressure also gets doubled .

If the volume of a given mass of a gas is doubled at constant temperature , the same number of molecules will have double the space to move about .The number of molecules striking at unit area of the walls of the container at a given time will become half of the original value . So , the pressure of the gas will be reduced to half of its original pressure .

Hence , IF PRESSURE INCREASES ,THE VOLUME OF THE GIVEN MASS OF GAS DECREASES .

NUMERICALS

EXAMPLE 1 : **A gas occupies 800 cm^3 under 760 mm Hg pressure . Find under what pressure the gas will occupy 380 cm^3 , the temperature remaining constant .**

SOLUTION : P_1 = 760 mm of Hg P_2 = ?

V_1 = 800 cm^3 V_2 = 380 cm^3

By Boyle's Law $P_1V_1 = P_2V_2$

$760 \times 800 = P_2 \times 380$

$\frac{760 \times 800}{380} = P_2$

P_2 = 1600 mm Hg .

THE REQUIRED PRESSURE IS 16OO mm OF Hg OR 160 cm of Hg . ANS

EXAMPLE 2 : **A gas occupies 600 cm^3 under a pressure of 700 mm Hg . Find under what pressure the volume of the gas will be reduced by 20 percent of its original volume , the temperature remaining constant throughout .**

SOLUTION : P_1 = 700 mm Hg P_2 = ?

V_1 = 600 cm^3 V_2 = 600 – 20 % of 600

= 600 – 120

= 480 cm^3

$P_1V_1 = P_2V_2$

$700 \times 600 = P_2 \times 480$

$\frac{760 \times 600}{480} = P_2$

P_2 = 875 mm of Hg

THE REQUIRED PRESSURE IS 875 mm of Hg ANS

EXAMPLE 3 : **The capacity of one cylinder is 4 dm^3 and that of the other is 1 dm^3 , the pressure in the first cylinder is 560 mm Hg and that in the second is 1000 mm of Hg . Both of these cylinders , containing carbon dioxide , are connected together by a tube fitted with a tap . What will be the final pressure in either cylinder on opening the tap if the temperature remains constant .**

SOLUTION : **Total volume of the gas on opening the gas = 1 + 4 = 5 dm^3**

FOR THE FIRST CYLINDER

$$P_1V_I = P_2V_2$$

$$560 \times 4 = P_2 \times 5$$

$$\frac{560 \, x \, 4}{5} = P_2$$

$$P_2 = 448 \text{ mm Hg}$$

FOR THE SECOND CYLINDER

$$P_1V_I = P_2V_2$$

$$1000 \times 1 = P_2 \times 5$$

$$\frac{1000 \, x \, 1}{5} = P_2$$

$$P_2 = 200 \text{ mm Hg}$$

Final Pressure = 448 + 200 = 648 mm Hg ANS

1) Volume of a certain amount of a gas at 25 ^{O}C and 100 mm Hg pressure is 80 ml . The gas is expanded
To 160 ml . Calculate the pressure of the expanded gas . **[50 cm of Hg]**

2) At a particular temperature , a certain quantity of gas occupies a volume of 74 cm^3 at a pressure of 760 mm . If the pressure is decreased to 740 mm , what will be the volume of the gas at the same
temperature . **[76 cm^3]**

3) At a constant temperature , volume of a gas was found to be 400 cm^3 at a pressure of 760 mm Hg .
If the pressure of the gas is increased by 25 % , find the new volume . **[320 cm^3]**

4) At a constant temperature , a gas is at a pressure of 1080 mm Hg . If the volume is decreased by 40
% , find the new pressure of the gas . **[1800 mm of Hg]**

5) A vessel of capacity 600 cm^3 contains hydrogen gas at a pressure of 330 cm Hg . What will be the pressure of hydrogen gas , when the vessel is connected to another vessel of 300 cm^3 capacity .
[220 cm Hg]